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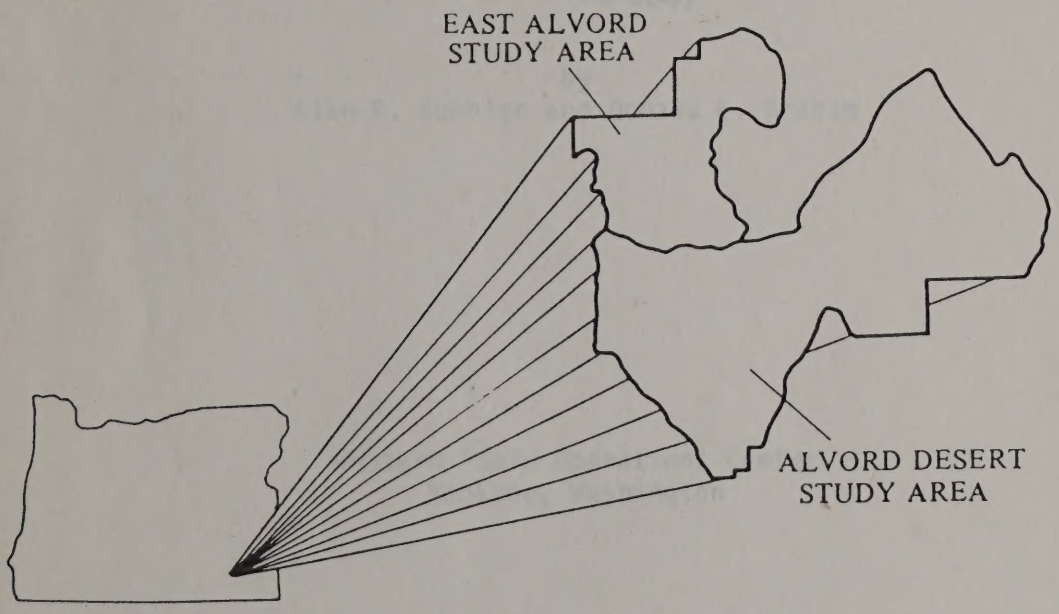
Open File Report

Mineral Resources of the Alvord Desert and East Alvord Study Areas, Harney and Malheur Counties, Oregon



BUREAU OF MINES

UNITED STATES DEPARTMENT OF THE INTERIOR

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MINERAL RESOURCES OF THE ALVORD DESERT AND EAST ALVORD STUDY AREAS, HARNEY AND MALHEUR COUNTIES, OREGON

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UNITED STATES DEPARTMENT OF THE INTERIOR
Donald P. Hodel, Secretary

BUREAU OF MINES
David S. Brown, Acting Director

PREFACE

The Federal Land Policy and Management Act of 1976 (Public Law 94-579, Sec. 603, October 21, 1976) requires the U.S. Geological Survey and U.S. Bureau of Mines to conduct mineral surveys on U.S. Bureau of Land Management administered land ". . . prior to any recommendations for the designation of an area as wilderness . . . to determine the mineral values, if any, that may be present . . ." Results must be made available to the public and submitted to the President and the Congress. This report presents the results of a Bureau of Mines mineral survey of portions of the Alvord Desert (OR-002-074) and East Alvord (OR-002-073A) Wilderness Study Areas, Harney and Malheur Counties, OR.

This open-file report will be summarized in a joint report published by the U.S. Geological Survey. The data were gathered and interpreted by Bureau of Mines personnel from Western Field Operations Center, East 360 Third Avenue, Spokane, WA 99202. The report has been edited by members of the Branch of Resource Evaluation at the field center and reviewed at the Division of Mineral Land Assessment, Washington, DC.

CONTENTS

	Page
Summary	4
Introduction	4
Setting	5
Previous studies	5
Present study	9
Geologic setting	10
Mining history	10
Sample results	11
Appraisal of mineral resources	12
References	14

ILLUSTRATIONS

Figure 1. Location of the Alvord Desert and East Alvord study areas, Harney and Malheur Counties, OR 6

2. Sample localities in and adjacent to the Alvord Desert and East Alvord study areas, Harney and Malheur Counties, OR 7

UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

$/oz	dollar per troy ounce
$/yd^3	dollar per cubic yard
ft	feet
in.	inch
mi	mile
oz	troy ounce
ppm	part per million

SUMMARY

In 1986, at the request of the U.S. Bureau of Land Management, the U.S. Bureau of Mines studied part of the 256,430-acre Alvord Desert and part of the 22,240-acre East Alvord Wilderness Study Area (OR-002-074 and OR-002-073A, respectively), in order to evaluate their identified mineral resources. The study areas are located in Harney and Malheur Counties, OR, about 25 mi northeast of the small village of Fields.

There are no mines, prospects, or identified mineral resources inside the study areas. Basalt flows within the study areas contain chalcedony-lined vugs and banded agate which may be of interest to rock hounds. An ignimbrite flow contains perlitic material, but crystalline contaminants make it unsuitable for commercial uses. Lacustrine (lake) sediments contain diatomite and clays, and evaporite crusts contain boron too low grade to profitably mine. Small quantities of common opal and petrified wood occur which might be of possible interest to rock hounds. Some of the petrified wood is black, free of fractures, and polishes well; it may be suitable as backing material for soft, thin, and brittle gemstones, such as precious opal. The lacustrine sediments also contain black, fetid layers which have above background, but economically insignificant concentrations of zinc, cobalt, nickel, barium, iron, manganese, aluminum, and potassium. Large quantities of fine-grained dune sands within the study areas are too far from markets for economic consideration. Ephemeral streams in the study areas contain small amounts of placer gold of no economic interest. The western portions of both study areas are reported to have moderate favorability for occurrences of natural gas, and both study areas are reported to have high favorability for the occurrence of geothermal resources. As of December 1986, oil and gas leases covered 3,700 acres in the study areas.

INTRODUCTION

This report describes the USBM (U.S. Bureau of Mines) portion of a cooperative study with the USGS (U.S. Geological Survey) to evaluate mineral resources and mineral resource potential of parts of the Alvord Desert and East Alvord WSAs (Wilderness Study Areas) 1/ at the request of the BLM (U.S. Bureau of Land Management). The USBM uses all pertinent mining-activities data and information from site-specific examinations of mine workings or known mineral occurrences to identify mineral resources. The USGS uses areal geological, geochemical, and geophysical surveys to evaluate the potential for undiscovered resources. Results of

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1/ WSA (Wilderness Study Area): a roadless area or island that has been inventoried by the U.S. Bureau of Land Management and found to have wilderness characteristics as described in Section 603 of the Federal Land Policy and Management Act of 1976 and Section 2(c) of the Wilderness Act (78 Stat. 891).

these investigations are combined and will be used to help determine the acceptability of the study areas for inclusion into the National Wilderness Preservation System. Although the immediate goal of this and other USBM mineral surveys is to provide data for the President, Congress, government agencies, and the public for land-use decisions, the long-term objective is to ensure that the Nation has an adequate and dependable supply of minerals at a reasonable cost.

Setting

The Alvord Desert study area encompasses 69,165 acres of the 256,430-acre Alvord Desert WSA (OR-002-074), and the East Alvord study area encompasses 15,785 acres of the 22,240-acre East Alvord WSA (OR-002-073A). The study areas, on federal lands within the Burns and Vale Districts of the BLM, are about 25 mi northeast of Fields, OR, and 55 mi southeast of Burns, OR (fig. 1). The eastern border of the Alvord Desert playa is the western boundary of both study areas (fig. 2). Unimproved roads delineate most of the study area boundaries, and jeep trails access portions of their interiors.

Overall relief is about 1,380 ft; elevations range from a low of 4,006 ft, approximately 2 mi southwest of Alvord Well No. 4 on the western edge of the Alvord Desert study area, to a high of 5,384 ft atop a gently sloping rise 2.5 mi south of Mickey Springs.

The study areas are in an arid climatic zone; average annual precipitation is less than 10 in. Temperatures range from about -20 to 105 ^{o}F and average about 55 ^{o}F. No perennial streams drain the study areas, and only various types of brush and grasses are present.

Previous Studies

Regional geologic mapping was initially done by Russell (1884) in a reconnaissance survey of southern Oregon. Subsequent regional studies of the geology and water resources of southern Oregon were by Russell (1903a and b), Waring (1909), and Fuller and Waters (1929). Walker and Peterson (1969) described the geology of the Basin and Range Province of Oregon, and Bradley (1982) compiled general information on mining districts and mineral deposits in the province. Walker (1977) compiled the geology of Oregon east of the 121st meridian. Walker and Repenning (1965) compiled a geologic map of the Adel Quadrangle. Smith (1927) studied the Steens-Pueblo fault block, 7 mi to the west, whose rocks are similar to the study area's. Wilkerson (1958) and Fryberger (1959) further mapped the geology, and Lund and Bentley (1976) discussed the geology and geomorphology of portions of Steens Mountain. Griscom and Conradi (1975) interpreted magnetometer and gravity profiles and related them to the structural geology, thickness of alluvium, and hot springs of the Alvord Valley. Brown and Peterson (1980) reported on the geology of the Alvord Desert area. Hook (1981) described the volcanic stratigraphy of the Mickey Springs area.

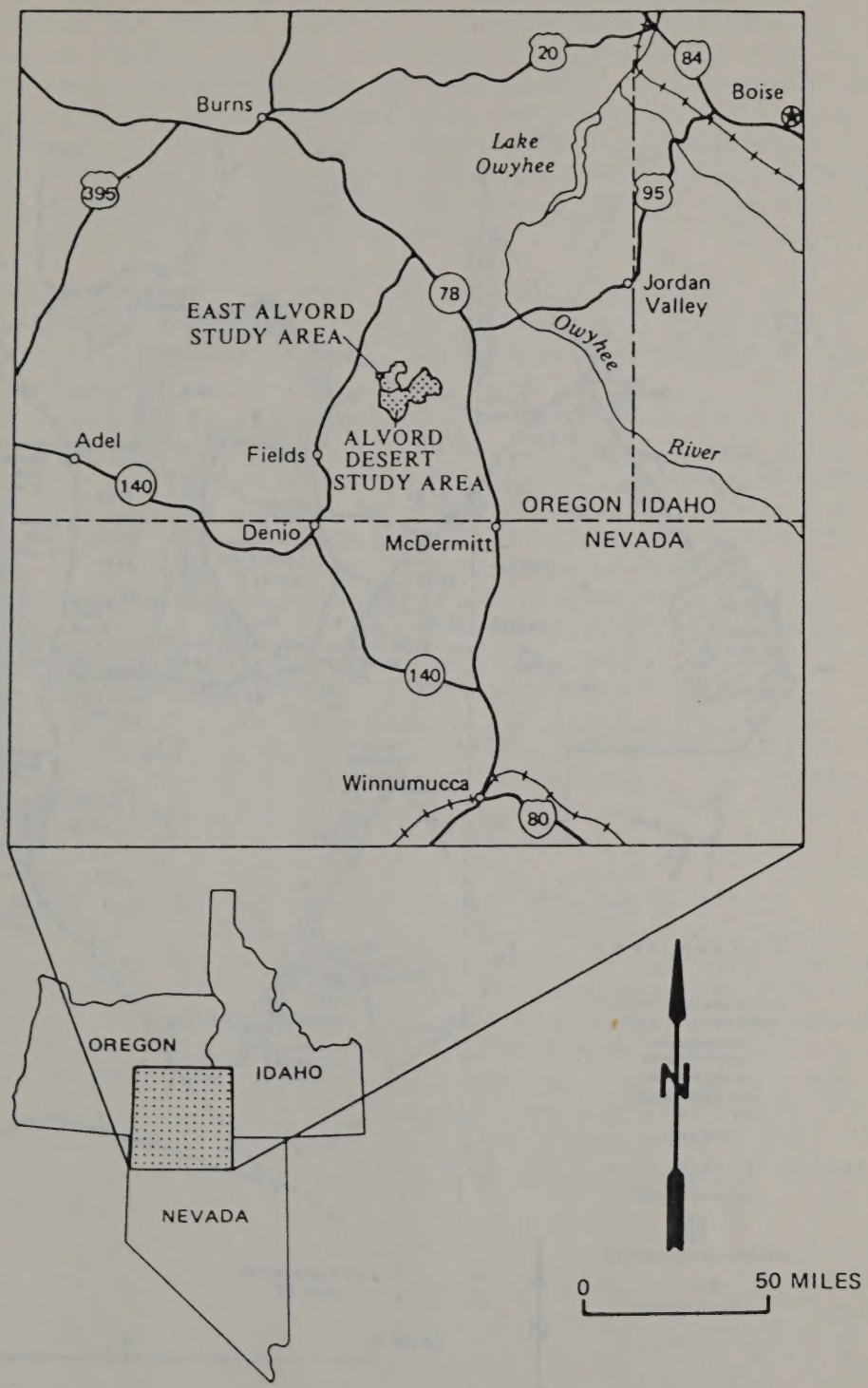

FIGURE 1.– Location of the Alvord Desert and East Alvord study areas, Harney and Malheur Counties, OR

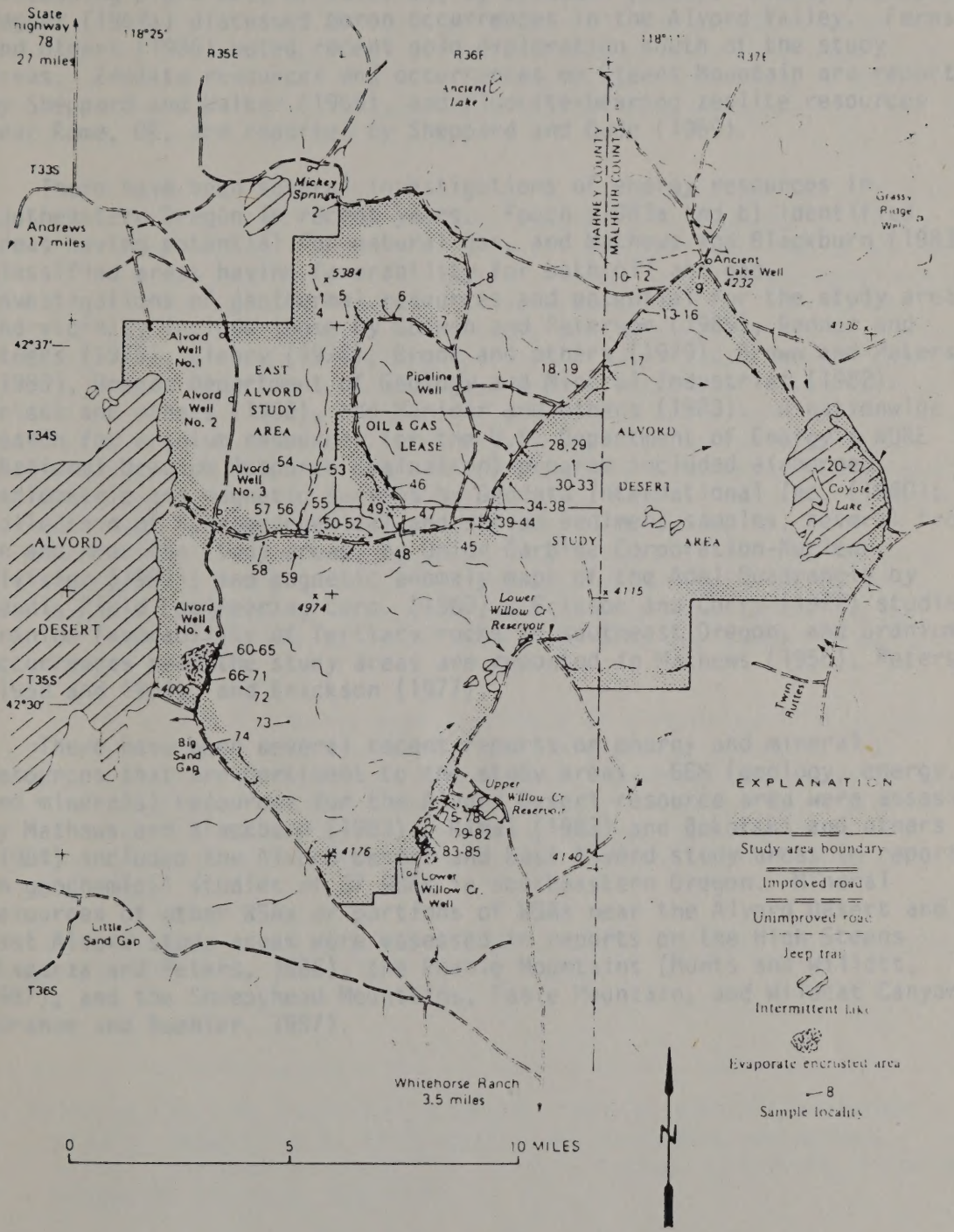

FIGURE 2.– Sample localities in and adjacent to the Alvord Desert and East Alvord study areas, Harney and Malheur Counties, OR

There are several kinds of mineral resources and occurrences in southeastern Oregon in rock types similar to those within the study areas. Mercury deposits west of the study areas are discussed by Ross (1942) and Williams and Compton (1953). Diatomite occurrences are reported by Wagner (1969b), and the new Eagle-Picher diatomite mine and processing plant west of Vale, OR, by Brittain (1986). Libbey (1960) and Wagner (1969a) discussed boron occurrences in the Alvord Valley. Ferns and others (1986) noted recent gold exploration south of the study areas. Zeolite resources and occurrences on Steens Mountain are reported by Sheppard and Walker (1969), and fluorite-bearing zeolite resources near Rome, OR, are reported by Sheppard and Gude (1969).

There have been several investigations of energy resources in southeastern Oregon in recent years. Fouch (1983a and b) identified areas having potential for natural gas, and Mathews and Blackburn (1983) classified areas having favorability for both oil and gas. Investigations of geothermal resources and potential for the study areas and vicinity include those by Godwin and Peterson (1969), Renner and others (1975), Cleary (1976), Brook and others (1979), Brown and Peterson (1980), Oregon Department of Geology and Mineral Industries (1982), Priest and others (1982), and Mariner and others (1983). A nationwide search for uranium resources for the U.S. Department of Energy's NURE (National Uranium Resource Evaluation) program included airborne radiometric and magnetic surveys by Geodata International Inc. (1980); collection of hydrogeochemical and stream sediment samples, several from in and near the study areas, by Union Carbide Corporation-Nuclear Division (1982); and magnetic anomaly maps of the Adel Quadrangle by Bendix Field Engineering Corp. (1983). Erikson and Curry (1977) studied uranium favorability of Tertiary rocks in southeast Oregon, and uranium occurrences near the study areas are reported in Mathews (1956), Peterson (1958 and 1969), and Erickson (1977).

There have been several recent reports on energy and mineral resources that are pertinent to the study areas. GEM (geology, energy, and minerals) resources for the Alvord Desert resource area were assessed by Mathews and Blackburn (1983). Rimal (1983) and Bukofski and others (1984) included the Alvord Desert and East Alvord study areas in reports on geochemical studies of 37 WSAs in southeastern Oregon. Mineral resources of other WSAs or portions of WSAs near the Alvord Desert and East Alvord study areas were assessed in reports on the High Steens (Esparza and Peters, 1986), the Pueblo Mountains (Munts and Willett, 1987), and the Sheepshead Mountains, Table Mountain, and Wildcat Canyon (Graham and Buehler, 1987).

Present Study

Work by USBM personnel entailed prefield, field, and report preparation phases in 1986 and 1987. The prefield study included library research and perusal of BLM mining and mineral lease records, county claim records, and Bureau of Mines production records. The field study, conducted in May, June, and July of 1986, included ground searches for evidence of mining-related activities and mineralized areas that might not have been reported. Eighty-five samples were collected in the study areas, including 69 rock and sediment samples from 23 locations, and 16 placer (alluvial) samples (fig. 2).

The 69 rock and sediment samples were analyzed by various methods, some by more than one. Eleven of the samples were analyzed by plasma emission spectroscopy (inductively coupled argon-plasma) for 24 elements 2/. Thirty-one samples were analyzed for boron by emission spectrography and for lithium by atomic absorption spectrophotometry. Thirty-two samples suspected of containing zeolites were checked for cation exchange capacity by a simple field test (Helfferich, 1964); many tested positive, so all were analyzed by x-ray diffraction for zeolites. These 32 samples were also analyzed by specific ion electrode analysis for fluorine. Six samples were analyzed for gold by fire assay with atomic absorption spectrophotometry finish; three of the six were also analyzed for mercury by atomic absorption spectrophotometry. Two samples suspected of being perlitic were checked by immersion of small pieces into a series of liquids of known refractive indices. The indices of the samples were then compared to those of material known to be perlitic (Kady, 1963), and the type and quantity of crystaline contaminants were determined by visual inspection. One sample of petrified wood was taken for appraisal purposes.

The 16 alluvial samples were comprised of a level-full 14-in. pan at each sample site of sand and gravel from dry stream channels. The samples were panned to a rough concentrate, screened, and processed on a Wilfley table 3/. The resulting heavy-mineral fractions were scanned with a binocular microscope to determine the type and amount of heavy-minerals present, and then examined for radioactivity and fluorescence.

Sample analyses are available from the USBM, Western Field Operations Center, E. 360 Third Ave., Spokane, WA 99202.

2/ Aluminum, barium, beryllium, bismuth, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, phosphorus, potassium, silver, sodium, strontium, titanium, tungsten, vanadium, and zinc.

3/ Reference to specific company names or products does not imply endorsement by USBM.

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The 60 rock and sediment samples were analyzed by various methods, some by more than one. Eleven of the samples were analyzed by plasma emission spectroscopy (inductively coupled argon-plasma) for 24 elements [2]. Thirty-one samples were analyzed for boron by emission spectrography and for iodine by atomic absorption spectrophotometry. Thirty-two samples suspected of containing zeolites were checked for cation exchange capacity by a simple field test (Mumpton, 1984); many tested positive, so all were analyzed by x-ray diffraction for zeolites. These 32 samples were also analyzed by specific ion electrode analysis for fluorine. Six samples were analyzed for gold by fire assay with atomic absorption spectrophotometry finish; three of the six were also analyzed for mercury by atomic absorption spectrophotometry. Two samples suspected of being perlite were checked by immersion of small pieces into a series of liquids of known refractive indices. The indices of the samples were then compared to those of material known to be perlitic (Kady, 1983), and the type and quantity of crystalline contaminants were determined by visual inspection. One sample of petrified wood was taken for appraisal purposes.

The 16 alluvial samples were composed of a level-full (6-in. pan of each sample site of sand and gravel from dry stream channels. The samples were panned to a rough concentrate, screened, and processed on a Gilpin table [3]. The resulting heavy-mineral fractions were scanned with a binocular microscope to determine the type and amount of heavy-mineral present, and then examined for radioactivity and fluorescence.

Sample analyses are available from the USBM, Western Field Operations Center, E. 360 Third Ave., Spokane, WA 99202.

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[2] Aluminum, barium, beryllium, bismuth, cesium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, phosphorus, potassium, silver, sodium, strontium, titanium, tungsten, vanadium, and zinc.

[3] Reference to specific company names or products does not imply endorsement by USBM.

GEOLOGIC SETTING

Rocks in the study areas, from oldest to youngest, are the Steens Basalt, Mickey Ignimbrite, and the Mickey Basalt. The 15.1±.3-million-year-old Steens Basalt is a 3,000 ft thick series of porphyritic basalt flows that average about 20 ft thick (Hook, 1981, p. 7). A rhyolitic ignimbrite flow, informally named the Mickey Ignimbrite (Hook, 1981), conformably overlies the Steens Basalt; it averages about 30 ft thick and includes a densely welded, vitric, central portion. Conformably overlying the Mickey Ignimbrite is a series of dark-colored, aphanitic basalt flows, informally named the Mickey Basalt, that is no more than 400 ft thick.

The study areas include land in both the Great Basin and the Columbia Intermontane (Plateau) geomorphic provinces (Thornbury, 1965, p. 462). The study areas are situated on the eastern limb of a large anticline, with Steens Mountain, 7 mi to the west, on the western limb. The Alvord Desert valley was formed when the central portion of the anticline downdropped about 5,500 ft along north-trending, high-angle, normal (range-front) faults that formed steep escarpments on either side (Fuller and Waters, 1929). The west escarpment is the east face of Steens Mountain, and the east escarpment is a line of cliffs or steep slopes up to about 1,000 ft high that trend north through the study areas. From the east escarpment, both study areas extend west to the edge of the Alvord Desert playa. East of the escarpment in the East Alvord study area, the terrain consists of steep hills dissected by northeasterly trending faults (Walker and Repenning, 1965). East of the escarpment in the Alvord Desert study area is a gently sloping basin with internal drainage into Coyote Lake's playa.

West of the escarpment and in Coyote Lake basin the rock formations are covered by lacustrine sediments, alluvium, colluvium, and eluvium. The lacustrine sediments contain unaltered and partially devitrified volcanic glass, clay, diatoms, quartz, and feldspars, and in places appears partially cemented, possibly by calcite brought in by groundwater. The rock formations and lacustrine sediments are presently being eroded and reworked by water, wind, and gravity to form the present stream sediments, sand dunes, and scree slopes.

MINING HISTORY

No mining claims are known to have been located in the study areas, and no evidence of mining activity was found during the field study. The nearest mining district (Steens Mountain) is on the opposite side of the Alvord Desert, 10 mi west of the study areas. The district has produced a small amount of mercury, and occurrences of lode and placer gold, perlite, uranium-bearing minerals, and zeolite have been reported (Esparza and Peters, 1986). Rocks exposed in the study area correlate with those on Steens Mountain (Hook, 1981), but little exploration seems to have been done on the east side of the Alvord Desert.

As of December 1986, approximately 3,700 acres within the study areas were under lease for oil and gas exploration (fig. 2). No land was leased for geothermal resources in 1986; however, there were several leases in the recent past, and exploratory drilling for low-temperature geothermal resources occurred near the northern border of the East Alvord study area.

SAMPLE RESULTS

Of the 11 samples checked for 24 elements 2/, 3 hand-augered samples (fig. 2, nos. 63-65) of very fine-grained, unconsolidated, black, fetid lacustrine sediment from the southwest portion of the Alvord Desert study area contained above background amounts of zinc, cobalt, nickel, barium, iron, manganese, aluminum, and potassium. The remaining samples, three rock and five sediment (fig. 2, nos. 50-52, 60, 66, 75, 79, 83), showed only background amounts of the 24 elements.

Boron was detected in all of the 31 hand-augered sediment samples taken from two white, evaporite-encrusted regions in the southwest portion of the Alvord Desert study area and the Coyote Lake playa (fig. 2, nos. 20-27, 60-71, 75-85); 15 of the samples (nos. 20, 60-64, 66-70, 75, 79, 82, 83) contained boron ranging from 0.01 to 0.09 percent. The 31 samples were also analyzed for lithium; no measurable concentrations were found.

No zeolites were detected in any of the 32 samples (fig. 2, nos. 4, 6, 9-17, 19, 28-45, 57, 73) suspected of containing them; the cation exchange capacity indicated by the field test may be due to the presence of clays which also have cation exchange capacity. All of the 32 samples contained fluorine; 31 had 0.12 percent or less, and 1 showed 1.65 percent (an insignificant aberration).

The six samples assayed for gold included three samples of fetid lacustrine sediment from the west side of the Alvord Desert study area (fig. 2, nos. 63-65), and two samples of silicified basalt and one of an iron-rich, fracture-fill material from the southeast portion of the East Alvord study area (fig. 2, nos. 50-52). All of the samples contained less than 0.002 oz gold per ton. The basalt and fracture-fill samples were also analyzed for mercury and showed 30, 30, and 70 ppm, respectively.

Of the 16 placer samples, 8 (fig. 2, nos. 2, 18, 46, 49, 53, 56, 58, 72) contained less than $0.06/yd^3$ (calculated with gold at $400.00/oz); the remaining 8 contained no gold (fig. 2, nos. 1, 7, 8, 47, 48, 54, 55, 74).

Two samples of rhyolitic ignimbrite from the northeast portion of the East Alvord study area (fig. 2, nos. 3, 5) showed refractive indices within the required range for perlitic material, but they contained a high percentage of contaminants, mostly feldspar crystals.

One sample of petrified wood from near the boundary between the study areas was cut and polished. The exterior, a thin rind, is tan to gray but the interior of some of the pieces is black, free of fractures, and polishes well.

APPRAISAL OF MINERAL RESOURCES

Samples of black, fetid, very fine-grained lacustrine sediments in the southwest portion of the Alvord Desert study area contain higher than background amounts of zinc, cobalt, nickel, barium, iron, manganese, aluminum, and potassium, but no resources were identified. The samples were from an area suspected of having concealed thermal waters, and precipitation of minerals from the waters might explain the above background concentrations of these elements. It is also possible that the sediments contain the remains of plants which had selectively absorbed elements from ground waters and concentrated those specific elements in the sediments.

Small quantities of very fine gold occur in dry stream channels within the study areas. The quantities and particle sizes are similar to placer gold occurrences reported in other drainages in the vicinity (Esparza and Peters, 1986; Munts and Willett, 1987; Graham and Buehler, 1987), These gold occurrences are too low grade to invite commercial interest.

Small amounts of chalcedony (banded agate and coated vugs), petrified wood, and common opal occur in the lacustrine sediments and basalt flows within the study areas. These materials are not commercially minable but may be of interest to hobbyists (rock hounds). The petrified wood and opal occur in lacustrine sediments near the road dividing the two study areas. The easily polished, black, relatively fracture-free interiors of some of the petrified wood may be suitable backing material for soft, thin, and brittle gemstones, such as precious opal. The basalt flows exposed along the escarpment contain chalcedony-lined vugs and banded agate. The vug linings (similar to geodes) and banded agate are generally not of good quality; most are tan to gray or white and vary in thickness from 1/16 in. to 1 in., but some of the vugs are greater than 3 in. across and many contain botryoidal coatings of light green to white chalcedony in their interiors.

Most of the unconsolidated lacustrine sediments within the study areas contain diatoms and clays, but these occurrences are too impure for commercial uses.

Large quantities of dune sand, which may be suitable for construction purposes, lie within the Alvord Desert study area, but this material does not constitute a resource because transportation costs to regional markets would be prohibitive.

The western portions of both study areas are within the Alvord Valley KGRA (Known Geothermal Resource Area), and the study areas are rated as having high favorability for the occurrence of geothermal resources (Brown and Peterson, 1980). They identified the Mickey Springs area, centered 2 mi northwest of the East Alvord study area, as worthy of further investigation for usable low-temperature geothermal water found at less than about 1 mi deep. The Mickey Springs system is believed to be associated with a major fault north of the study area which may serve as the channelway for the thermal waters. As of December 1986, no land in the study areas was under lease for geothermal exploration. However, there were several leases in the recent past, and exploratory drilling for low-temperature geothermal resources was done near but outside the northern border of the East Alvord study area. Evaporite crusts are associated with some thermal springs in the region, and there are two locations inside the study areas where there are crusts but no thermal springs. The crusts may be the surface manifestation of thermal waters venting into lacustrine sediments at depth. The evaporite crusts are enriched in boron (0.01 to 0.09 percent), but not sufficently to be profitably mined, as was done in the Hot Lake area, 15 mi to the southwest.

The western portions of both study areas are reported to have a medium favorability for the occurrence of oil and gas (Fouch, 1983a and b). In December 1986, approximately 3,700 acres within the Alvord Desert study area were under lease for oil and gas exploration. At that time, no drilling or other exploration had been done inside the study areas.

The rhyolitic ignimbrite flow in the northeast portion of the East Alvord study area contains volcanic glass with refractive indicies in the range of perlite; however, the material contains 40 to 60 percent feldspar crystals as contaminants. This amount renders the material unsuitable for commercial uses; perlite presently mined contains 5 percent or less contaminants.

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